

**ACADEMY of HEALTH
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**GENERAL
CHEMISTRY**



TABLE OF CONTENTS

Chapter		Paragraph	Page
1	ELEMENTS OF CHEMICAL STRUCTURE		
	Introduction	1	1
	Importance of Chemistry	2	1
	Matter	3	2
	Energy	4	6
	Atomic Structure	5	6
	Valence and Chemical Bonding	6	9
	Formula Writing	7	15
2	RULES OF INORGANIC NOMENCLATURE		
	Introduction	8	17
	General Terms	9	17
	Number Prefixes	10	18
	Naming Metallic Cations	11	18
	Naming Anions	12	20
	Naming Salts	13	23
	Naming Binary Acids	14	24
	Naming Ternary Acids	15	25
	Naming Bases	16	26
	Naming Covalent Inorganic Compounds	17	26
	Waters of Hydration	18	28
3	ELEMENTS OF CHEMICAL CHANGE		
	Chemical Reactions	19	30
	Writing Chemical Equations	20	32
	Example	21	32
	Equilibrium Reactions	22	33
	External Conditions Affecting Chemical Reactions ..	23	33
	Reacting Quantities	24	34
	Oxidation Reduction Reactions	25	36
	Acids and Bases	26	38
	Salts	27	41
	pH and Acidity	28	44
	Buffers	29	46
	Water	30	46
	Solutions	31	48

TABLE OF CONTENTS (CONT'D)

Chapter		Paragraph	Page
4	ELEMENTS OF ORGANIC CHEMISTRY		
	Introduction	32	51
	Contrast with Inorganic Chemistry	33	51
	Structural Formulas	34	51
	Carbon	35	52
	Carbon-Carbon Bonding	36	52
	Hydrocarbons	37	53
	Introduction to Functional Groups	38	56
	Alcohols	39	56
	Phenols	40	58
	Ethers	41	58
	Amines	42	59
	Carboxylic Acids	43	60
	Aldehydes	44	61
	Ketones	45	64
	Esters	46	64
	Amides	47	65
	Halogenated Hydrocarbons	48	66
	Summary	49	66

LIST OF ILLUSTRATIONS

Figure

1	First four electron shells	8
2	Identifying the components of the periodic table	11
3	Flow of electric current through electrolyte solution	50

LIST OF TABLES

Table

1	Elements, symbols, atomic numbers, and atomic weights in alphabetical order	3
2	Periodic table of the elements	10
3	Valences	14
4	Relative strength of common acids and bases	42
5	Salt types resulting from various acid-base combinations	44
6	Comparison of organic and inorganic chemistry	51
7	Common alkanes	54
8	Summary of properties for functional groups	62

CHAPTER 1

ELEMENTS OF CHEMICAL STRUCTURE

1. INTRODUCTION

Chemistry is the science which studies the composition and changes in composition of the substances around us. Man's natural curiosity about the things and transformations that he observed was the original impetus for the development of this science, but its true beginning was in the work of the alchemists of the Middle Ages. These men searched for a way to change the base metals such as lead into gold. In the large span of time since then, chemistry has developed into a true science and we have amassed a tremendous volume of knowledge. To facilitate the study of chemistry, we can divide it into two divisions: inorganic chemistry, which deals with the elements and mineral materials, and organic chemistry, which deals with compounds containing carbon. More divisions of chemistry exist, but we will be primarily concerned with these two.

2. IMPORTANCE OF CHEMISTRY

Why do we study chemistry? The answer to this question will be apparent when you consider the various classes of compounds we encounter in medicine and in our daily lives. For example, we are concerned with compounds such as drugs and the changes they undergo. Here are some things chemistry will tell us about drugs.

a. **Actions.** Chemistry may tell us about the actions of drugs on the body. Drug effects are determined by the chemical structure of a drug; changes in structure may alter the actions of the drug.

b. **Safety and Storage Procedures.** Special safety or storage precautions may be necessary for particular drugs. These can be identified by the chemical structure.

c. **Incompatibilities.** Sometimes two or more drugs cannot be mixed because of undesirable consequences. There are three types of incompatibilities.

(1) **Chemical.** Alterations of chemical properties may occur when two or more drugs are mixed.

(2) **Physical.** Physical properties of ingredients may produce a mixture unacceptable in appearance or accuracy of dosage.

(3) **Therapeutic.** When two or more drugs are given to a patient, they may interact in some way to change the effects of one of the drugs.

3. MATTER

Matter is anything which occupies space and has weight. If you look around you, you will see matter. The table, books, walls, and your body are all composed of matter. Obviously, the matter around you is not all the same.

a. **Physical States of Matter.** In general we can group all matter into three groups called states of matter.

(1) *Solids.* Solids have a definite shape and volume. Examples of solids are books, rocks, pieces of steel, and sand.

(2) *Liquids.* Liquids have a definite volume but indefinite shape. That is, they take the shape of their container. Water, mercury, alcohol, and oils are liquids.

(3) *Gases.* Gases do not have a definite shape nor a definite volume. They assume not only the shape of their container, but also their volume. Gases may be expanded or compressed to fit the container in which they are being placed. Thus the air in an automobile tire would, if released, expand to fill a large weather balloon.

b. **Properties of Matter.** Matter possesses two types of properties, physical and chemical. Characteristics such as smell, color, shape, freezing point, boiling point, and solubility are said to be physical properties of matter. Energy content, reactions with other substances, and chemical reactions due to light, heat, and electricity are said to be chemical properties of matter. From the physical and chemical properties exhibited by a substance, it is possible to isolate, identify, and classify the particular substance.

c. **Classification of Pure Matter.** Matter that cannot be separated into two or more types of matter by *physical* means is called pure matter. Pure matter consists of two types, elements and compounds.

(1) *Elements.* Substances that cannot be separated into two or more types of matter by *physical* or *chemical* methods are called elements. Another way to say this is that they consist of only one type of atom. An *atom* is a chemical building block and can be defined as the smallest part of an element which remains unchanged during any chemical reaction and exhibits or displays the chemical properties of that element. Examples of common elements are oxygen, gold, iron, mercury, hydrogen, and carbon. Table 1 lists the elements with their symbols, atomic numbers, and atomic weights.

(2) *Compounds.* Compounds are substances which have been purified by physical means, but not by chemical methods. They are composed of two or more elements chemically combined. They can be separated into two or more types of matter by chemical methods because their basic unit, the molecule, is a combination of two or more types of atoms. Illustrated at the top of page 6 are the relationships of these building blocks and classifications of matter.

ELEMENT	SYMBOL	ATOMIC NUMBER	ATOMIC WEIGHT
Actinium	Ac	89	227
* Aluminium	Al	13	26.9815
Americium	Am	95	243
Antimony	Sb	51	121.75
Argon	Ar	18	39.948
* Arsenic	As	33	74.9216
Astatine	At	85	210
* Barium	Ba	56	137.34
Berkelium	Bk	97	247
Beryllium	Be	4	9.0122
* Bismuth	Bi	83	208.980
* Boron	B	5	10.811
* Bromine	Br	35	79.909
Cadmium	Cd	48	112.40
* Calcium	Ca	20	40.08
Californium	Cf	98	249
* Carbon	C	6	12.01115
Cerium	Ce	58	140.12
Cesium	Cs	55	132.905
* Chlorine	Cl	17	35.453
Chromium	Cr	24	51.996
* Cobalt	Co	27	58.9332
* Copper	Cu	29	63.54
Curium	Cm	96	247
Dysprosium	Dy	66	162.50
Einsteinium	Es	99	254
Erbium	Er	68	167.26
Europium	Eu	63	151.96
Fermium	Fm	100	253
* Fluorine	F	9	18.9984
Francium	Fr	87	223
Gadolinium	Gd	64	157.25
Gallium	Ga	31	69.72
Germanium	Ge	32	72.59
* Gold	Au	79	196.967
* Denotes elements most common to medicine.			

Table 1. Elements, symbols, atomic numbers, and atomic weights in alphabetical order (continued).

ELEMENT	SYMBOL	ATOMIC NUMBER	ATOMIC WEIGHT
Hafnium	Hf	72	178.49
Helium	He	2	4.006
Holmium	Ho	67	164.930
• Hydrogen	H	1	1.00797
Indium	In	49	114.82
• Iodine	I	53	126.9044
Iridium	Ir	77	192.2
• Iron	Fe	26	55.847
Krypton	Kr	36	83.80
Kurchatovium	Ku	104	257
Lanthanum	La	57	138.91
Lawrencium	Lw	103	257
• Lead	Pb	82	207.19
• Lithium	Li	3	6.939
Lutetium	Lu	71	174.97
• Magnesium	Mg	12	24.312
• Manganese	Mn	25	54.9380
Mendelevium	Md, Mv	101	256
• Mercury	Hg	80	200.59
Molybdenum	Mo	42	95.94
Neodymium	Nd	60	144.24
Neon	Ne	10	20.183
Neptunium	Np	93	237
Nickel	Ni	28	58.71
Niobium	Nb, Cb	41	92.906
• Nitrogen	N	7	14.0067
Nobelium	No	102	254
Osmium	Os	76	190.2
• Oxygen	O	8	15.9994
Palladium	Pd	46	106.4
• Phosphorus	P	15	30.9738
Platinum	Pt	78	195.09
Plutonium	Pu	94	242
Polonium	Po	84	210
• Potassium	K	19	39.102
• Denotes elements most common to medicine.			

Table 1. Elements, symbols, atomic numbers, and atomic weights in alphabetical order (continued).

ELEMENT	SYMBOL	ATOMIC NUMBER	ATOMIC WEIGHT
Praseodymium	Pr	59	140.907
Promethium	Pm	61	147
Protoactinium	Pa	91	231
• Radium	Ra	88	226
Radon	Rn	86	222
Rhenium	Re	75	186.2
Rhodium	Rh	45	102.905
Rubidium	Rb	37	85.47
Ruthenium	Ru	44	101.07
Samarium	Sm	62	150.35
Scandium	Sc	21	44.956
• Selenium	Se	34	78.96
• Silicon	Si	14	28.086
• Silver	Ag	47	107.870
• Sodium	Na	11	22.9898
• Strontium	Sr	38	87.62
• Sulfur	S	16	32.064
Tantalum	Ta	73	180.948
Technetium	Tc	43	99
Tellurium	Te	52	127.60
Terbium	Tb	65	158.924
Thallium	Tl	81	204.37
Thorium	Th	90	232.038
Thulium	Tm	69	168.934
Tin	Sn	50	118.69
Titanium	Ti	22	47.90
Tungsten	W	74	183.85
Uranium	U	92	238.03
Vanadium	V	23	50.942
Xenon	Xe	54	131.30
Ytterbium	Yb	70	173.04
Yttrium	Y	39	88.905
• Zinc	Zn	30	65.37
Zirconium	Zr	40	91.22

• Denotes elements most common to medicine.

Table 1. Elements, symbols, atomic numbers, and atomic weights in alphabetical order (concluded).